NOAA Technical Memorandum NMFS

JANUARY 2018

MARINE MAMMAL LIFE HISTORY: GUIDE TO BIOLOGICAL SAMPLE COLLECTION AND DATA ARCHIVE

Susan J. Chivers

Southwest Fisheries Science Center
NOAA, National Marine Fisheries Service
8901 La Jolla Shores Dr.
La Jolla, CA 92037

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

About the NOAA Technical Memorandum series

The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency which establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

In addition to its formal publications, the NMFS uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series, however, reflect sound professional work and may be referenced in the formal scientific and technical literature.

SWFSC Technical Memorandums are accessible online at the SWFSC web site. (http://swfsc.noaa.gov)

Print copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.
(http://www.ntis.gov)

Marine Mammal Life History:
Guide to biological sample collection and data archive

Susan J. Chivers
Southwest Fisheries Science Center
NOAA, National Marine Fisheries Service
8901 La Jolla Shores Dr.
La Jolla, CA 92037

Summary

The marine mammal life history sample and data archive originated with the fishery observer program for the eastern tropical Pacific (ETP) yellowfin tuna purse-seine fishery. One goal of this observer program was to collect biological samples from individual dolphins that could contribute to the assessment of fishery impacts on dolphin populations. Subsequently, biological studies became an integral part of the marine mammal assessment process. Through time, these studies have expanded to include characterizing the health and ecology of marine mammal populations in addition to their life history. A broad suite of biological tissue samples and data are collected for these studies. This document presents an overview of the current protocols and procedures used to collect and archive biological samples and data. A summary of past protocols is also included along with references to additional detail about the collection and preservation of biological samples for marine mammals.

Marine Mammal Life History:
Guide to biological sample collection and data archive

Table of Contents

List of Tables and Figures

Introduction

The collection of life history data from individual dolphins incidentally killed in the eastern tropical Pacific (ETP) yellowfin tuna purse-seine fishery began in about 1966 (Perrin 1969b, Gerrodette 2009). The National Marine Fisheries Service (NMFS) implemented a formal program to collect data on the fishery and dolphins killed to better understand the tuna-dolphin issue in 1971, and the Southwest Fisheries Science Center (SWFSC) formed a Data Management Group (DMG) in 1973 to automate the processing and archiving of data (Oliver 1991). The system developed by the DMG forms the core of the SWFSC's marine mammal life history (MMLH) sample and data archive.

These data are essential to life history studies as they contribute to describing species' natural history, fishery selectivity and inputs to population models (*e.g.* age-specific reproductive rates, longevity). Research has also provided insights into trophic relationships and environmental changes affecting populations. The development of numerous molecular techniques has facilitated more in depth life history studies and broader ecological studies. For example, the MMLH archive of samples and associated data about individual animals have facilitated technique development (Kellar *et al.* 2006), incorporation of photogrammetric data into life history studies (Chivers *et al.* 2016) and retrospective studies (Ruiz-Cooley *et al.* 2017).

The current MMLH program has evolved from an early focus on collecting samples and data for taxonomic and life history studies to collecting a broader suite of both samples and data to study marine mammal health and ecology. This document summarizes the program's current holdings and data management scheme. Key references to related field guides and sampling protocols are included. This document relies on those references to fully describe the MMLH biological sampling program and is not an exhaustive guide to collecting or processing marine mammal samples for life history studies.

The Marine Mammal Life History Program

Overview

The MMLH archive includes biological samples and associated data collected from individual marine mammals sampled by fishery observers for the ETP yellowfin purse-seine and the California drift and set gillnet (CAGN) fisheries, and members of the California stranding network. Additionally, samples and data from subsistence harvest and incidental research takes are maintained.

1. Fishery observer programs

    a. The NMFS ETP observer program was implemented in 1966 and ended in 1994. Collection procedures changed through time (see Appendix 1).

    b. The NMFS CAGN observer program was implemented in 1990 and continues. The biological sampling program implemented was based on the ETP program as it existed in 1990. Collection protocols have remained constant through time.

2. Stranding network

    a. Opportunistic: Worldwide, stranded marine mammals have been of interest to marine biologists for years as they often provide the only source of information about the distribution and life history of species. The earliest San Diego County record is from 1891 (Danil *et al.* 2010).

    b. Routine: The Marine Mammal Protection Act (MMPA) passed in 1972 specified that a national stranding network be established. This formalized data collection from stranded marine mammals and the SWFSC's stranding program as part of the national network. The SWFSC's program used the DMG's established protocols for data archiving. The primary focus of the SWFSC's stranding program is on dead beached cetaceans in San Diego County.

Protocols

Beginning in 1974, life history data collection procedures were standardized for the ETP observer program. The revised procedures specified sampling the first available dead dolphins brought aboard. This change was implemented to facilitate randomly sampling the incidental fishery kill and replaced the original sampling scheme of selectively sampling large, female specimens. The minimum data collection standards for each dolphin were to record the date,

geographic location, species, stock, sex and total body length. Several modifications to the collection of data and samples were made during the course of the program, and a chronological overview of the main changes is presented in Appendix 1.

Procedures for the collection of life history data are described in Perrin et al. (1976), and the data forms used to collect the data are included as appendices in Perrin and Oliver (1982). Information about the changes in protocols are largely captured in Oliver (1991), and additional sampling protocol details with updated data forms are available in Myrick (1986) and Jefferson et al. (1994). A reproduction of the final data form used is included here as Data Form 1 in Appendix 7. Several studies have evaluated potential biases in sample collection, including protocol changes and sampling techniques, and the under-sampling of calves (e.g., Chivers and Akin 1991, Archer et al. 2001, Kellar et al. 2013).

The CAGN observer program essentially implemented the ETP observer program as it existed in 1990, and relied on the Myrick (1986) and Jefferson et al. (1994) field sampling guides. A reproduction of the current data form used is included here as Data Form 2 in Appendix 7. Unique to the CAGN program is that skin sampling for molecular genetic studies was implemented (Chivers et al. 1997). This facilitated accurate species identification for estimating species-specific mortality by the fleets using molecular genetic techniques, which is especially important for incidentally killed marine mammals too large to bring aboard the vessel and species difficult to identify in the field (e.g. common dolphins) (Julian and Beeson 1998, Carretta et al. 2004). Fishery closure areas were designated to protect sea turtles in 2000, which resulted in limiting the CAGN fleet to fishing in the Southern California Bight (SCB).

The sampling protocols developed for the fishery observer programs also form the core of the stranding program's sampling protocols. Additional information about sampling stranded marine mammals is also available in Geraci and Lounsbury (2005) and St. Aubin *et al.* (1996). Information about sample collection and processing for determining cause of death can be found in Dierauf and Gulland (2001).

In the field, fishery observers and stranding network responders assign a unique identifier to each animal, and record the species, stock or ecotype when appropriate, and sex of marine mammals along with the date and geographic location where collected. Total body length is also most often measured and recorded in the field. Additional biological samples, such as reproductive organs and teeth, are collected when feasible, and all biological samples collected are recorded on the field data form. All biological samples are returned to the SWFSC for further processing.

The unique identifier assigned to each animal sampled is referred to as the "specimen" number, which is the collector's initials (unique to each collector) and a sequential number. A list of fishery observer and stranding network member names, and the initials assigned to each

person is maintained by the NMFS Regional observer program and by the SWFSC Marine Mammal and Turtle Division manager for fisheries data.

Archive

Life-history data and biological samples are processed at the SWFSC. While some tissue samples are archived at the SWFSC, others are archived at museums or are sent to specialized laboratories for additional testing and processing.

In the laboratory, the field data for each specimen is reviewed for completeness and accuracy. Species identifications are confirmed by reviewing photographs or analyzing a genetic sequence. All data are entered into the MMLH database, which includes fields indicating the biological samples collected as well as derived data (*e.g.* reproductive status and age). The database records are supported by physical records, which include the field data sheets together with all accompanying documentation (*e.g.* photographs, biotoxin test results, histo-pathology reports and x-rays) are stored in the MMLH data archive. The conversion to digital photographs and X-ray technology means that some documentation is with the hard copy data records while others are stored digitally and filed by specimen number on the storage disk with the database.

Gonads, teeth, prey (*i.e.*, stomach contents), skin, blubber, muscle, internal organs (*e.g.* liver and kidney) and body fluids (*e.g.* blood and urine) are archived at the SWFSC (Table 1) as follows.

1. All dry or wet preserved samples are stored in the SWFSC's "Specimen Archive" and are archived by type and number as follows.

    a. Adrenals are ordered by their assigned accession number: A#,

    b. Gonads are ordered by cruise number,

    c. Histology samples are stored in the archival drawers and ordered alphabetically by their assigned specimen number,

    d. Prey preserved from examination of stomach contents are ordered by the stomach's accession number: S#,

    e. Teeth are ordered by their assigned accession number: TH#,

2. Stomachs are stored frozen whole in the necropsy freezer in lidded gray plastic "Stomach boxes" until processing and are stored by specimen number,

3. Frozen tissues, fluids and swabs are stored in the thru-put freezer in designated boxes, which are labeled and numbered,

4. Serum is stored in the Freezer Farm's F3 -80 freezer by specimen number,

5. Fetal specimens are archived at the Los Angeles County Museum of Natural History (LACM), and

6. Osteological specimens were collected by ETP fishery observers through 1992. The carcasses and skulls were prepared at the SWFSC or the National Museum of Natural History and dispersed to museums in several countries. Skulls and complete skeletons (n = 2,434) are archived at 17 museums (Perrin and Chivers 2011). Additional osteological specimens from the CAGN observer and stranding program are archived at LACM. Additional skulls representing most cetacean species are archived and maintained as a research collection in the SWFSC's Taxonomy Laboratory (Gilpatrick and Walker 1986).

Table 1. *Fisheries by-catch: Number of specimens collected by species.*

Species	Specimens (n)
Balaenoptera sp.	2
Balaenoptera acutorostrata	2
Balaenoptera physalus	1
Delphinus capensis	62
Delphinus delphis	3239
Delphinus sp.	558
Enhydra lutris	3
Eschrichtius robustus	3
Eumetopias jubatus	1
Feresa attenuata	1
Globicephala macrorhynchus	12
Grampus griseus	33
Kogia breviceps	1
Kogia sima	1
Lagenodelphis hosei	16
Lagenorhynchus obliquidens	84
Lissodelphis borealis	77
Mesoplodon carlhubbsi	5
Mesoplodon stejnegeri	1
Mirounga angustirostris	102
Orcinus orca	1
Peponocephala electra	2
Phoca vitulina	241
Phocoena phocoena	35
Phocoena sinus	1
Phocoena spinipinnis	1
Phocoenoides dalli	22
Physeter macrocephalus	3
Pseudorca crassidens	2
Stenella attenuata	26752
Stenella attenuata graffmani	328
Stenella attenuata subsp.	39
Stenella coeruleoalba	342
Stenella longirostris	6023
Stenella longirostris centroamericana	87
Stenella longirostris orientalis	6207
Stenella longirostris subsp.	585
Steno bredanensis	37
Tursiops truncatus	122
Unidentified to species	9
Zalophus californianus	715
Ziphius cavirostris	10
Total	**45768**

Table 2. *San Diego County strandings: Number of specimens collected by species.*

Species	Specimens (n)
Arctocephalus townsendi	2
Balaenoptera	6
Balaenoptera acutorostrata	3
Balaenoptera edeni	1
Balaenoptera musculus	4
Balaenoptera physalus	14
Delphinus capensis	244
Delphinus delphis	133
Delphinus sp.	115
Enhydra lutris	3
Eschrichtius robustus	97
Eubalaena japonica	1
Globicephala macrorhynchus	21
Grampus griseus	15
Kogia breviceps	17
Lagenorhynchus obliquidens	57
Lissodelphis borealis	16
Megaptera novaeangliae	7
Mesoplodon carlhubbsi	3
Mesoplodon ginkgodens	1
Mesoplodon perrini	4
Mesoplodon sp.	1
Mirounga angustirostris	19
Phoca vitulina	22
Phocoena phocoena	3
Phocoenoides dalli	19
Physeter macrocephalus	3
Stenella attenuata	3
Stenella coeruleoalba	5
Stenella longirostris subsp.	1
Tursiops truncatus	169
Unidentified to species	44
Zalophus californianus	187
Ziphius cavirostris	15
Total	1255

Table 3. *Strandings (non-San Diego County), research takes, subsistence harvest and other collection types: Number of specimens archived by species.*

Species	Specimens (n)
Arctocephalus townsendi	1
Balaena mysticetus	28
Balaenoptera acutorostrata	1
Balaenoptera borealis	1
Balaenoptera musculus	2
Balaenoptera physalus	1
Delphinus capensis	215
Delphinus delphis	108
Eschrichtius robustus	3
Feresa attenuata	13
Globicephala macrorhynchus	6
Grampus griseus	4
Kogia breviceps	3
Kogia sima	1
Lagenorhynchus albirostris	2
Lagenorhynchus obliquidens	18
Lissodelphis borealis	5
Megaptera novaeangliae	3
Mesoplodon europaeus	1
Orcaella brevirostris	12
Orcinus orca	1
Phocoena phocoena	14
Phocoena sinus	8
Phocoenoides dalli	2
Physeter macrocephalus	8
Pontoporia blainvillei	15
Pseudorca crassidens	4
Stenella attenuata	10
Stenella coeruleoalba	3
Stenella frontalis	1
Stenella longirostris	5
Stenella longirostris orientalis	1
Tursiops truncatus	16
Unidentified to species	2
Zalophus californianus	187
Ziphius cavirostris	1
Total	706

Table 4. *Summary of specimens collected (a) and archived (b) for life history studies.*

(a)

Data type	Specimens (n)
Morphology	46840
Reproduction	43880
Age	15991
Weights (body & organ)	2601
Food habits (prey id)	1887
Male histology	1470
Stranding details	1160
Bone	304
Biotoxin	232
Physical maturity	185
Contaminants (POPs)	163
Heavy metals	129

(b)

Sample type	Specimens (n)
Teeth	33094
Gonads	31826
Histology Slides	5423
Frozen (e.g. blubber, organs)	1557
Adrenal glands	1538
Histological samples for pathology	251

Methods summary for key life history parameters: Age, Reproduction and Food habits

Age

Age is determined by counting growth layer groups (GLGs) in the dentine and cementum of the prepared tooth sections (Myrick *et al.* 1983). GLGs are interpreted as annual events based on conclusions from calibration experiments on captive Hawaiian spinner dolphins (Myrick *et al.* 1984) and known-age bottlenose dolphins (*Tursiops truncatus*) from the wild (Hohn *et al.* 1989; Hohn 1990). This model continues to be considered the appropriate model for small delphinids (Murphy *et al.* 2014, Hohn *et al.* 2016).

A subset of dolphins sampled have age determined and archived in the MMLH database.

Reproduction

Gonads collected from individual dolphins are processed and examined at the SWFSC to determine reproductive maturity. In summary, the presence of one corpus or more in the ovaries indicates sexual maturity in females (see Perrin and Reilly 1984), and evidence of spermatogenesis in histologically prepared testes tissue indicates sexual maturity in males (e.g. Hohn *et al.* 1985). Details of the ovary processing techniques are in Akin *et al.* (1993). Proxies of sexual maturity using dolphin size and gonad weight (*e.g.* average length, gonad weight at attainment of sexual maturity) are also available for some species to infer sexual maturity when gonads were not collected or examined.

A subset of female marine mammals are determined to be pregnant, and if the fetus is collected, it is sexed, measured and preserved for future studies. All field and laboratory derived data are recorded in the MMLH database.

Food habits

ETP and CAGN observers collected stomachs from a subset of dolphins incidentally killed. Stomachs were frozen in the field and returned for later processing in a laboratory (see Robertson and Chivers 1997 for overview of methodology and additional references), which included weighing before and after removal of contents, and identification of the prey remains found in the forestomach. Stomachs of stranded specimens that are relatively fresh (*i.e.*, carcass code 2 or 3) are also collected and processed.

The Marine Mammal Life History Database

The MMLH database consists of a series of related tables that store the primary data collected from individual marine mammals for life history studies as well as the inventory of samples stored at the SWFSC in a database called MMLH (Figure 1). A secondary set of tables within MMLH contain the details of what biological samples are stored where (*i.e.*, the inventory tables named with a pre-fix "Inv"). Supporting code tables are in MMLH if they are life history related (see Appendix 6) or in the SQL database SWFSCCommon if they are more general and used by other databases within the SWFSC Marine Mammal and Turtle Division (*e.g.* species code tables, city names). Additional tables to track sample activity (*e.g.* biological sample transfers (aka 'loans') for education, research studies or technique development) and stranding reports are stored in a Microsoft ACCESS database (Appendix 4). Links to all SQL tables are also in this database.

Field definitions for primary data tables are provided in Appendix 5, and the companion code tables are presented in Appendix 6.

The Specimen field links MMLH data to additional data in SWFSC databases maintained by the molecular genetics and wildlife endocrinology laboratories.

Figure 1. Schematic of the Marine Mammal Life History (MMLH) database. Legend: White = primary SQL data tables, Dark Gray = sample or activity tracking ACCESS data tables, Black = biological sample inventory SQL data tables, Gray hatched = code tables in SQL.
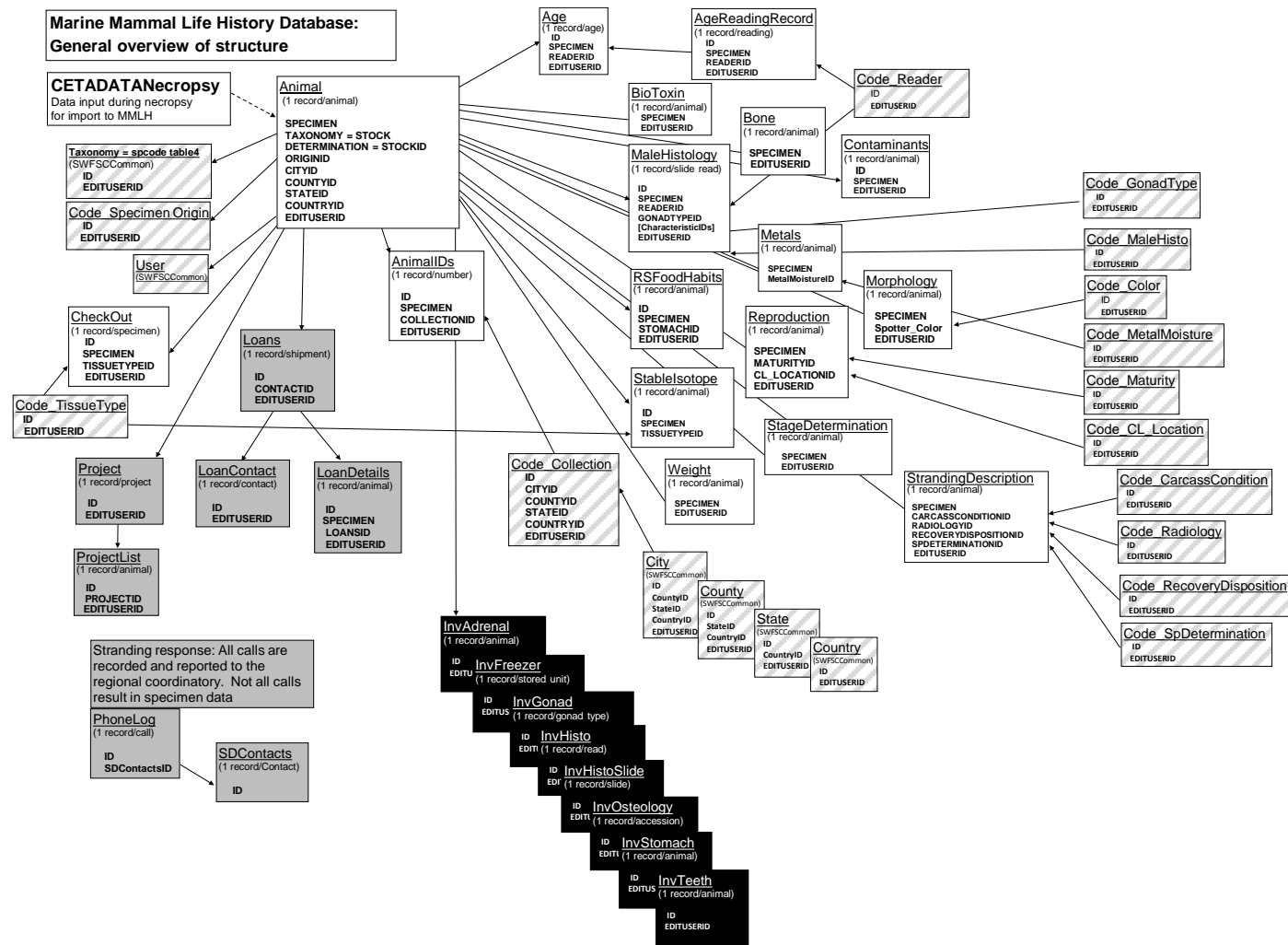
Literature cited

Akin, P. A., K. M. Peltier and R. B. Miller. 1993. Techniques for the preparation and examination of reproductive samples collected from dolphins in the eastern tropical Pacific. NOAA, Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-192. 26 pp.

Archer, E., T. Gerrodette, A. E. Dizon, K. Abella and S. Southern. 2001. Unobserved kill of nursing dolphin calves in a tuna purse-seine fishery. Marine Mammal Science 17:540-554.

Carretta, J. V., T. Price, D. Petersen and R. Read. 2004. Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. Marine Fisheries Review 66:21-30.

Chivers, S. J. and P. A. Akin. 1991. Sampling effects on the estimation of life history parameters for eastern tropical Pacific dolphins. Reports of the International Whaling Commission 42:525-527.

Chivers, S. J., W. L. Perryman, M. S. Lynn, *et al.* 2016. Comparison of reproductive parameters for populations of eastern North Pacific common dolphins: *Delphinus capensis* and *D. delphis*. Marine Mammal Science 32:57-85. DOI: 10.1111/mms.12244.

Chivers, S. J., K. M. Robertson and M. D. Henshaw. 1997. Composition of the incidental kill of cetaceans in two California gillnet fisheries: 1990–1995. Rep Int. Whal. Commn 47:909–915.

Danil, K., S. J. Chivers, M. D. Henshaw, J. L. Thieleking, R. Daniels and J. A. St. Leger. 2010. Cetacean strandings in San Diego County, California, USA: 1851-2008. Journal of Cetacean Research Management 11:163-184.

Dierauf, L. A. and F. M. D. Gulland (eds). 2001. CRC Handbook of Marine Mammal Medicine. CRC Press, Boca Raton. 1063 pp.

Geraci, J. R. and V. J. Lounsbury. 2005. Marine Mammals Ashore: A Field Guide for Strandings. National Aquarium in Baltimore, Baltimore, MD.

Gerrodette, T. 2009. The tuna-dolphin issue. Pages 1192-1195 *in* W. F. Perrin, B. Wursig and J. G. M. Thewissen, eds. Encyclopedia of Marine Mammals, 2nd edition. Academic Press, Amsterdam. pp.

Gilpatrick, J. W. and G. J. Walker. 1986. Osteological catalog: User's guide and documentation. A microcomputer-based system for managing osteological specimens. Administrative Report LJ-86-14. 46 pp.

Hohn, A. A., S. J. Chivers and J. Barlow. 1985. Reproductive maturity and seasonality of male spotted dolphins, *Stenella attenuata*, in the eastern tropical Pacific. Marine Mammal Science 1:273-293.

Hohn, A. A., C. Lockyer and M. Acquarone. 2016. Report of the workshop on age estimation in monodontids. Tampa, FL, USA. 26-27 November 2011. NAMMCO Scientific Publications 10:68. DOI: 10.7557/3.3742.

Jefferson, T., A., A. C. Myrick and S. J. Chivers. 1994. Small cetacean dissection and sampling: a field guide. NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFSC-198. 54 pp. pp.

Julian, F. and M. Beeson. 1998. Estimates of marine mammal, turtles, and seabird mortality for two California gillnet fisheries:1990-1995. Fishery Bulletin 96:271-284.

Kellar, N. M., M. L. Trego, S. J. Chivers, F. I. Archer, J. J. Minich and W. L. Perryman. 2013. Are there biases in biopsy sampling? Potential drivers of sex ratio in projectile biopsy samples from two small delphinids. Marine Mammal Science 29:E366-E389. DOI: 10.1111/mms.12014.

Kellar, N. M., M. L. Trego, C. I. Marks and A. E. Dizon. 2006. Determining pregnancy from blubber in three species of delphinids. Marine Mammal Science 22:1-16.

Murphy, S., M. Perrott, J. Mcvee, F. L. Read and K. A. Stockin. 2014. Deposition of growth layer groups in dentine tissue of captive common dolphins *Delphinus delphis*. NAMMCO Scientific Publications 10 DOI: 10.7557/3.3017.

Myrick, A. C., Jr. 1986. Procedures for sampling dolphins: A handbook for shipboard observers. NOAA, Technical Memorandum NMFS, NOAA-TM-NMFS-SWFC-62. 69 pp.

Myrick, A. C., Jr. 1988. Is tissue resorption and replacement in permanent teeth of mammals caused by stress-induced hypocalcemia? Pages 379-389 *in* Z. Davidovitch, ed. The Biological Mechanisms of Tooth Eruption and Root Resorption. EBSCO Media, Birmingham, Alabama. pp.

Myrick, A. C., Jr., A. A. Hohn, P. A. Sloan, M. Kimura and D. D. Stanley. 1983. Estimating age of spotted and spinner dolphins (*Stenella attenuata* and *Stenella longirostris*) from teeth. NOAA, Technical Memorandum NMFS, NOAA-TM-NMFS-SWFC-30. 17 pp.

Myrick, A. C., Jr., E. W. Shallenberger, I. Kang and D. B. Mackay. 1984. Calibration of dental layers in seven captive Hawaiian spinner dolphins, *Stenella longirostris*, based on tetracycline labeling. Fishery Bulletin. 82:207-225.

Norris, K. S. 1961. Standardized methods for measuring and recording data on the smaller cetaceans. Journal of Mammalogy 42:471-476.

Oliver, C. 1991. Documentation of the 1959-1988 editing criteria for porpoise life history data: porpoise data management system. Administrative Report LJ-91-07. 100 pp.

Perrin, W. F. 1969a. Color pattern of the eastern Pacific spotted porpoise *Stenella graffmani Lonnberg* (Cetacea, Delphinidae). Zoological Journal, New York Zoological Society 54:135-149.

Perrin, W. F. 1969b. Using porpoise to catch tuna. World Fishing 18:42-45.

Perrin, W. F., P. A. Akin and J. V. Kashiwada. 1991. Geographic variation in external morphology of the spinner dolphin *Stenella longirostris* in the eastern Pacific and implications for conservation. Fishery Bulletin, U.S. 89:411-428.

Perrin, W. F. and S. J. Chivers. 2011. Osteological specimens of tropical dolphins (*Delphinus, Grampus, Lagenodelphis, Stenella, Steno* and *Tursiops*) killed in the tuna fishery in the eastern tropical Pacific (1966 - 1992) and placed in museums by the Southwest Fisheries Science Center. 87 pp, NOAA Technical Memorandum NMFS-SWFSC-477. 87 pp.

Perrin, W. F., J. M. Coe and J. R. Zweifel. 1976. Growth and reproduction of the spotted porpoise, *Stenella attenuata*, in the offshore eastern tropical Pacific. Fishery Bulletin 74:229-269.

Perrin, W. F. and S. B. Reilly. 1984. Reproductive parameters of dolphins and small whales of the Family Delphinidae. Reports of the International Whaling Commission, Special Issue 6:97-133.

Robertson, K. M. and S. J. Chivers. 1997. Prey occurrence in pantropical spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific. Fishery Bulletin 95:334-348.

Ruiz-Cooley, R. I., T. Gerrodette, P. C. Fiedler, S. J. Chivers, K. Danil and L. T. Ballance. 2017. Temporal variation in pelagic food chain length in response to environmental change. Science Advances 3.

St. Aubin, D. J., J. R. Geraci and V. J. Lounsbury. 1996. Rescue, rehabilitation, and release of marine mammals: an analysis of current views and practices. NOAA, Technical Memorandum NMFS, NOAA-TM-NMFS-OPR-8. 65 pp.

Štěrba, O., M. Klima and B. Schildger. 2000. Embryology of dolphins: staging and ageing of embryos and fetuses of some cetaceans. Advances in anatomy embryology and cell biology 157:1-133.

Appendices

Appendix 1. Summary of eastern tropical Pacific yellowfin tuna purse-seine fishery observer program and changes to life history sampling protocols.

- 1971-72: Large adult females preferentially sampled. No instructions with respect to collecting fetal length data

- October 1973: Systematic sampling of U.S. vessels by NMFS observers; first full year of life history sampling under this scheme is 1974

- 1973-76: If fetus <1-ft, keep in uterus and preserve with 10% formalin; if >1-ft, sex, measure and discard.

- 1977: If fetus <25-cm, keep in uterus and preserve with 10% formalin; if >25-cm, sex, measure and discard.

- 1978: If fetus <25-cm, keep in uterus and preserve with 10% formalin; if >25-cm, sex, measure and freeze inside the Commission's Yellowfin Regulatory Area (CYRA) or discard outside the CYRA.

- 1979: IATTC starts sampling international fleet; life history sampling implemented using the same procedures as NMFS

- 1979-81: If fetus <25-cm, keep in uterus and preserve with 10% formalin; if >25-cm, sex, measure and freeze (inside or outside CYRA).

- 1982 & 1983: few life history samples collected… why? This observation seemed to prompt review of the sampling program and implementation of changes.

- 1982-90: If fetus <25-cm, keep in uterus and preserve with 10% formalin; if >25-cm, sex, measure and discard.

- mid-1980's: Increase in non-U.S. flagged vessels in the fleet; increase in IATTC observer coverage

- 1986: Total body length measuring device: Memo dated 2/25/1986 documents cruises that used the prototype measuring device beginning in 1982. Presumably, these were also used to measure fetuses >=25cm but not documented

- 1988: memo dated 3/28/1988 documents implementation of new life history data form; memo dated 9/30/1988 detailed implementation of bonus award program for sampling large kill sets. Program end date was not documented.

- 1989: Instruction in place to sample only from sets with >=7 animals killed (see Chivers and Akin 1991).

- 1990: fetal length data collection: memo dated 5/31/1990 noted error in data form and instructions to observers: both indicated that fetal length be recorded to the nearest cm; previously it was to the nearest 1/10 cm; all data collected by fishery observers and SWFSC laboratory personnel are recorded with this precision

- 1990: dolphin safe labelling begins, and the 1997 International Dolphin Conservation Program Act subsequently expanded the labelling guidelines
- 1992: 100% observer coverage of international fleet (size class 6 vessels)
- 1993: begin individual-vessel dolphin mortality limits for international fleet
- 1994: end of dolphin life history sampling program; NMFS no longer supports an ETP fishery observer program
- Observer manuals and documentation of the biological sampling program are stored with the Marine Mammal Life History data archive

Appendix 2. Latitude and Longitude: Guide to data entry and interpretation of decimal precision.

- Geographic location: a practical guide
    - Usually this information is recorded by the person who collected the specimen and may be written in degrees and minutes or as decimal degrees. Occasionally, these are determined later using the descriptive location information (e.g., beach, city).
    - Are stored as decimal degrees in the database. North and East are positive; South and West are negative.
    - Fields in the database include an indication of the precision of the information reported. For example, the precision of a handheld GPS unit like the one used on strandings is 0.5 seconds and the location data recorded at sea by California gill net observers 0.1 minutes (Table 1).
- Geographic location: a detailed guide to coding and interpreting data
    - The **sign** tells us whether we are north or south, east or west on the globe.
    - A nonzero **hundreds digit** tells us we're using longitude, not latitude!
    - The **tens digit** gives a position to about 1,000 kilometers. It gives us useful information about what continent or ocean we are on.
    - The **units digit** (one decimal degree) gives a position up to 111 kilometers (60 nautical miles, about 69 miles). It can tell us roughly what large state or country we are in.
    - The **first decimal place** is worth up to 11.1 km: it can distinguish the position of one large city from a neighboring large city.
    - The **second decimal place** is worth up to 1.1 km: it can separate one village from the next.
    - The **third decimal place** is worth up to 110 m: it can identify a large agricultural field or institutional campus.
    - The **fourth decimal place** is worth up to 11 m: it can identify a parcel of land. It is comparable to the typical accuracy of an uncorrected GPS unit with no interference.
    - The **fifth decimal place** is worth up to 1.1 m: it distinguish trees from each other. Accuracy to this level with commercial GPS units can only be achieved with *differential correction*.
    - The **sixth decimal place** is worth up to 0.11 m: you can use this for laying out structures in detail, for designing landscapes, building roads. It should be more than good enough for tracking movements of glaciers and rivers. This can be achieved by taking painstaking measures with GPS, such as differentially corrected GPS.
    - The **seventh decimal place** is worth up to 11 mm: this is good for much surveying and is near the limit of what GPS-based techniques can achieve.
    - The **eighth decimal place** is worth up to 1.1 mm: this is good for charting motions of tectonic plates and movements of volcanoes. Permanent, corrected, constantly-running GPS base stations might be able to achieve this level of accuracy.
    - The **ninth decimal place** is worth up to 110 microns: we are getting into the range of microscopy. For almost any conceivable application with earth positions, this is overkill and will be more precise than the accuracy of any surveying device.

- **Ten or more decimal places** indicates a computer or calculator was used and that no attention was paid to the fact that the extra decimals are useless. Be careful, because unless you are the one reading these numbers off the device, this can indicate low quality processing!

Table 1. Interpretation of decimal places in geographic positions.

Decimal places	Degrees	Distance	Distance unit
0	1	111.000	km
1	0.1	11.100	km
2	0.01	1.110	km
3	0.001	111.000	m
4	0.0001	11.100	m
5	0.00001	1.110	m
6	0.000001	0.111	m
7	0.0000001	1.110	cm
8	0.00000001	1.110	mm

Appendix 3. Summary of changes to recording reproductive data.

1. FOLL DIAM – Prior to 2010, 0.1 was entered if no follicles were observed. Starting in February 2010, "0" was entered if no follicles were observed. Please note that specimens staged in 2010 were actually collected before 2010.

2. FET LENGTH – Prior to 2005, straight crown or rostrum to tail length was taken (determined through comparison of Štěrba *et al.* (2000) measures to ours). However, it is not clear when one began measuring from the rostrum rather than the crown. Starting in 2005, began specifying whether fetal length was crown to rump, crown to tail, rostrum to tail, and whether measure was curvilinear. Curvilinear rostrum to tail appears to be clearest approach to fetal measures.

3. Corpora albicantia fields: CA1_L through CA6_L and CA1_R through CA6_R. Prior to 9/25/2014, the number of CAs based on type was recorded in these fields and their size was recorded on the data sheet. After this date, the number and dimension of corpora albicantia were not recorded and these fields are null in the database. However, the number present in the left and right ovary continue to be recorded in the fields CA_LEFT and CA_RIGHT, respectively. TOTALCORPORA is also recorded when both ovaries are examined.

Appendix 4. List of Marine Mammal Life History (MMLH) database tables.

Database	Table name	Table type
MMLH (SQL)	tbl_Age	Primary data/History
	tbl_AgeReadingRecord	Primary data
	tbl_Animal	Primary data/History
	tbl_AnimalIDs	Primary data
	tbl_BioToxin	Primary data
	tbl_Bone	Primary data
	tbl_CheckOut	Primary data
	tbl_Contaminants	Primary data
	tbl_MaleHistology	Primary data/History
	tbl_Metals	Primary data
	tbl_Morphology	Primary data/History
	tbl_Reproduction	Primary data/History
	tbl_RSFoodHabits	Primary data
	tbl_StableIsotope	Primary data
	tbl_StageDetermination	Primary data/History
	tbl_StrandingDesription	Primary data/History
	tbl_Weight	Primary data/History
	tbl_InvAdrenal	Inventory
	tbl_InvFreezer	Inventory
	tbl_InvGonad	Inventory
	tbl_InvHisto	Inventory
	tbl_InvHistoSlide	Inventory
	tbl_InvOsteology	Inventory
	tbl_InvStomach	Inventory
	tbl_InvTeeth	Inventory
	tblCode_CarcassCondition	Look up/Code table
	tblCode_CL_Location	Look up/Code table
	tblCode_Collection	Look up/Code table
	tblCode_Color	Look up/Code table
	tblCode_GonadType	Look up/Code table
	tblCode_MaleHisto	Look up/Code table
	tblCode_Maturity	Look up/Code table
	tblCode_MetalMoisture	Look up/Code table
	tblCode_Radiology	Look up/Code table
	tblCode_Reader	Look up/Code table
	tblCode_RecoveryDisposition	Look up/Code table
	tblCode_SpDetermination	Look up/Code table
	tblCode_SpecimenOrigin	Look up/Code table
	tblCode_TissueType	Look up/Code table
SWFSCCommon (SQL)	tbl_spcode_table4	Look up/Code table
	tblUser	Look up/Code table
	tblCity	Look up/Code table
	tblCounty	Look up/Code table
	tblState	Look up/Code table
	tblCountry	Look up/Code table
MMLH (MSAccess)	Loan Details	Activity tracking table
	LoanContacts	Activity tracking table
	Loans	Activity tracking table
	tblPhoneLog	Activity tracking table
	tblSDContacts	Activity tracking table
	tblProject	Activity tracking table
	tblProjectLists	Activity tracking table
	tblReadingRecord	Working/Project table
	tblHealth	Working/Project table
	tblPARASITE	Working/Project table
	tblAge_TM365_Micro_IA	Working/Project table
	tblDelphinusID	Working/Project table
	tblDelphinusToothMeasures	Working/Project table
	tblPINNLIFE	Working/Project table
CetaNecropsy (MSAccess)		For data entry during necropsy

Appendix 5. Table structure for primary data tables in the Marine Mammal Life History (MMLH) database.

tbl_Age

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
Age	Real		Final age, or growth layer group (GLG) count, for specimen
IsAnalysisQuality	Character	Y, N	Y or N for Yes/No
EstimationMethod	Character		Used for Age field. For example: Mean of a reader or readers; Pooled Mean = mean of all readers; Concensus; Variable length <= 20
AgeReader1	Real		Age from reader 1; usually mean of 3 reads
ReaderID1	Integer	Foreign key	Identifies reader 1: tblCode_Reader
AgeReader2	Real		Age from reader 2
ReaderID2	Integer	Foreign key	Identifies reader 2: tblCode_Reader
AgeReader3	Real		Age from reader 3
ReaderID3	Integer	Foreign key	Identifies reader 3: tblCode_Reader
AgeReader4	Real		Age from reader 4
ReaderID4	Integer	Foreign key	Identifies reader 4: tblCode_Reader
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_AgeReadingRecord

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
BlindID	Integer		used only for special studies; local db code table
Platform	Character	M or IA	M = microscope or IA = Image Analyzer
Reading	Integer	1 - 200	Sequential number of reading for Reader; usually 3 although mid-1980s ETP studies had > 100
ToothOfSpecimen	Character		Tooth section used to age (# from left to right on the
SlideCondition	Character		F=Faded, D=Dark, L=Light, S=Shredded, G=good, UD=under decalcified, OD=over decalcified; multiples of these codes can be entered
ReaderInitials	Character		
ReaderID	Integer	Foreign key	Match to tblCode_Reader
Date	Date		
PulpCavityCondition	Integer	1, 2, 3	1=open, 2=narrow,3=closed?/closed
AgeReaderMean	Real		Calculated after data entry
AgeBest	Real		
AgeHigh	Real		
AgeLow	Real		
DentineOrCementum	Character	D, C	D = Dentine or C = Cementum
Confidence	Integer	1 - 6	1=excellent,2=very good, 3=good, 4=ok, 5= marginal, 6=unacceptable
Note	Character		<= 300 characters
Resorption_CMR	Integer		For all 'resorption' fields see Myrick (1988)
Resorption_CML	Integer		
Resorption_CER	Integer		
Resorption_DMR	Integer		
Resorption_DML	Integer		
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; from
RecordCreationDate	Date	Short data; auto-entered	Date record created

tbl_Animal

Field Name	Type	Validation	Description
Specimen	Character	Primary key	<=20 characters
OriginID	Integer	Foreign key	tblCode_SpecimenOrigin
IsSWFSC	Character	Y, N	Y or N for Yes or No; indicates SWFSC originating specimen
IsDataSheet	Character	Y, N	Y or N for Yes or No
Cruise	Character		
Cruise_Set	Character		
Year	Integer	Four digit number	
Month	Integer	1-12	
Day	Integer	1-31	For strandings enter date first reported
Latitude	Real		In decimal degrees
Latitude_Precision	Real		See Appendix 2
Latitude_Precision_Unit	Character		See Appendix 2
Longitude	Real		In decimal degrees
Longitude_Precision	Real		See Appendix 2
Longitude_Precision_Unit	Character		See Appendix 2
CityID	Integer		SWFSCCommon.tblCity
CountyID	Integer		SWFSCCommon.tblCounty
StateID	Integer		SWFSCCommon.tblState
CountryID	Integer		SWFSCCommon.tblCountry
Stock	Character		SWFSCCommon.spcode_table4.SPCODE
StockID	Character	Foreign key	Code_SpDetermination.Code
Sex	Character	M, F, U	M(Male), F (Female), or U (Unknown)
Adrenals_Coll	Character		Y or N for Yes or No collected
Biopsy_Coll	Character		Y or N for Yes or No collected
Blood_Coll	Character		Y or N for Yes or No collected
Blubber_Coll	Character		Y or N for Yes or No collected
Brain_Coll	Character		Y or N for Yes or No collected
Carcass_Coll	Character		Y or N for Yes or No collected
Feces Coll	Character		Y or N for Yes or No collected
Fetus_Coll	Character		Y or N for Yes or No collected
FetusBiopsy_Coll	Character		Y or N for Yes or No collected
Gonad_Coll	Character		Y or N for Yes or No collected
Head_Coll	Character		Y or N for Yes or No collected
Histo_Coll	Character		Y or N for Yes or No collected
Kidney_Coll	Character		Y or N for Yes or No collected
Liver_Coll	Character		Y or N for Yes or No collected
Lung_Coll	Character		Y or N for Yes or No collected
Morphometry_Coll	Character		If more than Total Length measured, then Y or N for Yes or No, Otherwise null[1]
Muscle_Coll	Character		Y or N for Yes or No collected
Photos_Coll	Character		Y or N for Yes or No collected
Radiology_Coll	Character		Y or N for Yes or No collected
Skeleton_Coll	Character		Y or N for Yes or No collected
Spleen_Coll	Character		Y or N for Yes or No collected
Stomach_Coll	Character		Y or N for Yes or No collected
Teeth_Coll	Character		Y or N for Yes or No collected
Urine_Coll	Character		Y or N for Yes or No collected
Other_Coll	Character		Y or N for Yes or No collected
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

---

[1] Null is the default for all fields if no data available.

tbl_AnimalIDs

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
AccessionNumber	Character		unique number assigned by collection
CollectionID	Integer	Foreign key	tblCode_Collection
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_BioToxin

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
Process_Lab	Character		Identifies analytical laboratory
Process_LabID	Character		Identification number assigned by analytical lab at time of processing
IsDA	Character	Y, N	Y or N for Yes or No Domoic Acid (DA) present
IsSTX	Character	Y, N	Y or N for Yes or No Saxitoxin (STX) present
IsMC	Character	Y, N	Y or N for Yes or No Microsystin (MC) present
IsOA	Character	Y, N	Y or N for Yes or No Okadaic Acid (OA) present
DA_feces_ng	Real		Domoic Acid concentration (ng/g) of feces (i.e., colon contents)
DA_IntestCont	Integer		Domoic Acid concentration (ng/g) of intestinal contents, which may be sampled anywhere along intestinal tract, except for colon
DA_urine_ng	Real		Domoic Acid concentration (ng/g) of urine
DA_stomach content_ng	Real		Domoic Acid concentration (ng/g) of fore stomach contents
STX_feces_ng	Real		Saxitoxin concentration (ng/g) of feces (i.e., colon contents)
STX_IntestCont	Integer		Saxitoxin concentration (ng/g) of intestinal contents, which may be sampled anywhere along intestinal tract, except for colon
STX_urine_ng	Real		Saxitoxin concentration (ng/g) of urine
STX_stomach	Integer		Saxitoxin concentration (ng/g) of fore stomach contents
MC_feces_ng	Real		Microsystin concentration (ng/g) of feces (i.e., colon contents)
MC_urine_ng	Real		Microsystin concentration (ng/g) of urine
OA_feces_ng	Real		Okadaic concentration (ng/g) of feces (i.e., colon contents)
OA_urine_ng	Real		Okadaic concentration (ng/g) of urine
Method	Character		e.g. ELISA, DARA; <= 50 characters
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_Bone

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
Skull_RostralLength	Real		
Skull_ZygomaticWidth	Real		
MeasureDate	Date		
MeasureBy	Character		<= 50 characters
LGTHROW_U	Real		Length of Tooth Row, Upper
LGTHROW_L	Real		Length of Tooth Row, Lower
N_Total_Vertebrae	integer		
N_Cervical_Vetebrae	integer		
N_Thoracic_Vetebrae	integer		
N_Lumbar_Vetebrae	integer		
N_Caudal_Vetebrae	integer		
N_Ribs	integer		
N_DoubleHead	integer		
N_SingleHead	integer		
N_Chevron	integer		
N_Teeth_UpperL	integer		
N_Teeth_LowerL	integer		
N_Teeth_UpperR	integer		
N_Teeth_LowerR	integer		
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_CheckOut

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
TissueTypeID	Integer	Foreign key	tblCode_TissueType
IsFrozen	Character	Y, N	Y or N for Yes or No frozen
CheckOutUser	Character		name of user: first initial, last name
CheckOutDate	Date		
CheckInDate	Date		
Comments	Character		<= 300 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_Contaminants

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
SampleNumber	Character		assigned by processing lab; <= 50 characters
SetName	Character		assigned by processing lab; <= 50 characters
ReplicateType	Character		assigned by processing lab; <= 50 characters
SampleType	Character		assigned by processing lab; <= 50 characters
SampleDescription	Character		assigned by processing lab; <= 50 characters
SampleNote	Character		assigned by processing lab; <= 255 characters
SampleWt	Real		
CalcBasis	Character		
PercentLipid	Real		
LipidFormat	Real		
LipidGravimetricFormat	Real		
LipidIatroscan_Format	Real		
LipidIatro_SALE_Format	Real		
LipidIatro_TG_Format	Real		
LipidIatro_FFA_Format	Real		
CB103Recovery_Format	Real		
LipidIatro_Chol_Format	Real		
LipidIatro_PL_Format	Real		
HCB_Conc	Character		
aHCH_Conc	Character		
bHCH_Conc	Character		
lindane_Conc	Character		
achlor_Conc	Character		
cnona_Conc	Character		
bchlor_Conc	Character		
gchlor_Conc	Character		
hept_Conc	Character		
HPE_Conc	Character		
nona3_Conc	Character		
oxychlor_Conc	Character		
tnona_Conc	Character		
aldrin_Conc	Character		
diel_Conc	Character		
mirex_Conc	Character		
eslf1_Conc	Character		
cb17_Conc	Character		
cb18_Conc	Character		
cb28_Conc	Character		
cb31_Conc	Character		
cb33_Conc	Character		
cb44_Conc	Character		
cb49_Conc	Character		
cb52_Conc	Character		
cb66_Conc	Character		
cb70_Conc	Character		
cb74_Conc	Character		
cb82_Conc	Character		
cb87_Conc	Character		
cb95_Conc	Character		
cb99_Conc	Character		
cb101_Conc	Character		
cb105_Conc	Character		
cb110_Conc	Character		
cb118_Conc	Character		
cb128_Conc	Character		
cb138_Conc	Character		

Field Name	Type	Validation	Description
cb149_Conc	Character		
cb151_Conc	Character		
cb156_Conc	Character		
cb158_Conc	Character		
cb170_Conc	Character		
cb171_Conc	Character		
cb177_Conc	Character		
cb180_Conc	Character		
cb183_Conc	Character		
cb187_Conc	Character		
cb191_Conc	Character		
cb194_Conc	Character		
cb195_Conc	Character		
cb199_Conc	Character		
cb205_Conc	Character		
cb206_Conc	Character		
cb208_Conc	Character		
cb209_Conc	Character		
opDDD_Conc	Character		
opdde_Conc	Character		
opDDT_Conc	Character		
ppDDD_Conc	Character		
ppDDE_Conc	Character		
ppDDT_Conc	Character		
SumCHLDs_Conc	Character		
SumDDTs_Conc	Character		
SumHCHs_Conc	Character		
Sum40CBs_Conc	Character		
Sum6CBs_Conc	Character		
BDE28_Conc	Character		
BDE47_Conc	Character		
BDE49_Conc	Character		
BDE66_Conc	Character		
BDE85_Conc	Character		
BDE99_Conc	Character		
BDE100_Conc	Character		
Br5DE04_Conc	Character		
Br5DE05_Conc	Character		
BDE153_Conc	Character		
BDE154_Conc	Character		
Br6DE01_Conc	Character		
BDE155_Conc	Character		
BDE183_Conc	Character		
Br7DE01_Conc	Character		
SumBDE_Conc	Character		
ProcessDate	Date	Short date	Provided by processing laboratory
ProcessNote	Character		Provided by processing laboratory
ProcessLab	Character		Identifies processing laboratory
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_MaleHistology

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
GonadTypeID	Integer	Foreign key	tblCode_GonadType
Side	Character		<= 10 characters; L, R or U for left, right or unknown; Side 1, Side 2, A or as labeled on slide
InterstitialTissue	Integer	Foreign key	tblCode_MaleHisto.InterTiss_Space
InterstitialSpace	Integer	Foreign key	tblCode_MaleHisto.InterTiss_Space
Lumen	Integer	Foreign key	Relative size of the lumen: tblCode_MaleHisto.Lumen
TubuleElongation	Integer	Foreign key	Relative elongation of seminiferous tubules: tblCode_MaleHisto.TElon_Sperm
Spermatocytes	Integer	Foreign key	tblCode_MaleHisto.TElon_Sperm
Spermatids	Integer	Foreign key	tblCode_MaleHisto.TElon_Sperm
Spermatozoa	Integer	Foreign key	tblCode_MaleHisto.TElon_Sperm
Spermatogenesis	Integer		From 1970s ETP studies, see Perrin *et al.* (1976)
TubuleDiameter_1	Real		reticle measurement
TubuleDiameter_2	Real		reticle measurement
TubuleDiameter_3	Real		reticle measurement
TubuleDiameter_4	Real		reticle measurement
TubuleDiameter_5	Real		reticle measurement
TubuleDiameter	Real		mean of reticle measurements corrected to um; recorded to nearest 1/10 um
MaturityCode	Integer	Foreign key	tblCode_MaleHisto.Maturity
MaturityName	Character		<= 10 characters; not used currently; Maturity sub-stage codes from other studies
Comments	Character		<= 500 characters
ReadDate	Date		
ReaderID	Integer	Foreign key	tblCode_Reader
EpididymisState	Integer		From 1970s ETP studies
TestisDevelopment	Integer		From 1970s ETP studies
TestisTubuleDiameter	Real		From 1970s ETP studies
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_Metals

Note: L prefix = liver, K = kidney B = blood; values = concentration as ppm; when bdl (*i.e.*, below detection limit) data value is entered as ½ of detection limit. Detection limits (dl) are specified by element at time analyzed and are provided with case report. Values provided here are current for CAHFS, and they are the same for liver and kidney; see footnotes for prior values.

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
L_Pb	Real		Lead; dl = 1.0, if bdl = 0.5 ppm
L_Mn	Real		Manganese; dl = 0.1, if bdl = 0.05[2]
L_Fe	Real		Iron; dl = 1.0, if bdl = 0.5[3]
L_Hg	Real		Mercury; dl = 1.0, if bdl = 0.5 ppm
L_CH3HG	Real		Methyl mercury; rep limit = 10, if bdl = 5
L_As	Real		Arsenic; dl = 1.0, if bdl = 0.5 ppm
L_Mo	Real		Molybdenum; dl = 0.4, if bdl = 0.2 ppm
L_Zn	Real		Zinc; dl = 0.3, if bdl = 0.15 ppm[4]
L_Cu	Real		Copper; dl = 0.3, if bdl = 0.15 ppm[3]
L_Cd	Real		Cadmium; dl = 0.3, if bdl = 0.15 ppm
L_Se	Real		Selenium; dl = 0.02, if bdl = 0.01 ppm
L_PctMoisture	Real		Percent moisture, rep. limit = 0.5%
L_PctMoistureID	Integer	Foreign key	tblCode_MetalMoisture
K_Pb	Real		Lead; dl = 1.0, if bdl = 0.5 ppm
K_Mn	Real		Manganese; dl = 0.1, if bdl = 0.05[2]
K_Fe	Real		Iron; dl = 1.0, if bdl = 0.5[3]
K_Hg	Real		Mercury; dl = 1.0, if bdl = 0.5 ppm
K_As	Real		Arsenic; dl = 1.0, if bdl = 0.5 ppm
K_Mo	Real		Molybdenum; dl = 0.4, if bdl = 0.2 ppm
K_Zn	Real		Zinc; dl = 0.3, if bdl = 0.15 ppm[4]
K_Cu	Real		Copper; dl = 0.3, if bdl = 0.15 ppm[3]
K_Cd	Real		Cadmium; dl = 0.3, if bdl = 0.15 ppm
K_PctMoisture	Real		Percent moisture, rep. limit = 0.5%
K_PctMoistureID	Integer	Foreign key	tblCode_MetalMoisture
B_Se	Real		
Comments	Character		<= 200 characters
CAHFSCaseNumber	Character		a unique number assigned by UCDavis, CA Animal Health & Food Safety Laboratory (CAHFS); <= 50 characters
TestReportDate	Date	Short date	Date CAHFS case report authorized
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

---

[2] Prior to 2016, dl = 0.04 ppm; if bdl, entered as 0.02
[3] Prior to 2016, dl = 0.2 ppm; if bdl, entered as 0.1
[4] Prior to 2016, dl = 0.1 ppm; if bdl, entered as 0.05

tbl_Morphology

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
TotalLength_LAB	Real		
IsStandardTL_LAB	Character	Y, N	Y or N for yes or no standard length per Norris (1961); If 'No', indicate type of measurement in comments
TotalLength_FIELD	Real		
IsStandardTL_FIELD	Character	Y, N	Y or N for yes or no standard length Norris (1961) ; If 'No', indicate type of measurement in comments
IsAltMeasurementDeviceUsed	Character	Y, N	Y or N for yes or no
Spotter_Color	Integer	Foreign key	tblCode_Color; see Perrin (1969a)
Spinner_Morph	Integer		see Perrin *et al.* (1991) for all Spinner characters
Spinner_Cape	Integer		
Spinner_Fin	Integer		
Spinner_Belly	Integer		
STOANUS	Real		All measurements to nearest 1/10 cm; no estimates; # corresponds to number on data sheet 4, see Appendix 7; #2
STOGENSLIT	Real		#3
STOUMBIL	Real		#4
STOTHRGROO	Real		#5
STODOFINTIP	Real		#6
STOANTDOR	Real		#7
STOFLIPPER	Real		#8
STOEAR	Real		#9
STOEYE	Real		#10
STOGAPE	Real		#11
STOBLOHOLE	Real		#12
STOMELAPEX	Real		#13
ETOEAR	Real		#14
ETOGAPE	Real		#15
ETOBLOHL_L	Real		#16
ETOBLOHL_R	Real		#17
BLOHL_LGTH	Real		#18
BLOHLWDTH	Real		#18
DIAM_EAR	Character		#19; <= 5 characters
HEAD_DIAM	Real		#20
LGTH_EOP	Real		#21
ROSTWIDTH	Real		#22
PROJECTUP	Character		#23; <= 4 characters
PROJECTLOW	Character		#23; <= 4 characters
THROATGROOVE_N	Integer		#24
LGTH_GROO	Real		#25
FLIPLGTH_A	Real		#26
FLIPLGTH_P	Real		#27
FLIPWIDTH	Real		#28
LGTHMAMS_R	Real		#29
LGTHMAMS_L	Real		#29
MAMMSLIT_N	Integer		#30
LGTHGENSLI	Real		#31
LGTHANASLI	Real		#31
PERILGTH	Real		#32
FLUKWDTH	Real		#33
FLUKDPTH_L	Real		#34
FLUKDPTH_N	Real		#34
FLUKNTDPTH	Real		#35
DORFNHGT	Real		#36
DORFNBLGTH	Real		#37
GATEYE	Real		#38
GAAXILLA	Real		#39

Field Name	Type	Validation	Description
GIRTHMAX	Real		#40
GATANUS	Real		#41
GMIDANTONT	Real		#42
HGTSMPL	Real		#43
THICKSMPL	Real		#44
BLUBTHIK_D	Real		#45
BLUBTHIK_L	Real		#46
BLUBTHIK_V	Real		#47
BLUBTHIK_C	Real		#48
BlubberCompData	Character	Y, N	Y or N for yes or no; Blubber Composition Data from ETP work, coding and data collection criteria unverified (see Edwards, Worthy publications)
Pinn_CurvilinearLength	Real		
Pinn_FlipperLn_ForeAnt	Real		
Pinn_FlipperLn_HindAnt	Real		
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_Reproduction

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
IsSideKnown	Character	Y, N	Y or N for yes or no
IsMature	Character	Y, N, U	Y or N for yes or no and U for unknown and cannot be determined; includes info from tbl_MaleHistology
MaturityID	Integer	Foreign key	tblCode_Maturity; includes info from tbl_MaleHistology
IsLactating	Integer	Y, N	Y or N for yes or no; null (blank) if unknown
IsPregnant	Integer	Y, N	Y or N for yes or no; null if unknown
Follicle_Diam	Real		Unit = mm
OvaryLength_R	Real		Unit = mm
OvaryWidth_R	Real		Unit = mm
OvaryDepth_R	Real		Unit = mm
OvaryLength_L	Real		Unit = mm
OvaryWidth_L	Real		Unit = mm
OvaryDepth_L	Real		Unit = mm
CL_Diam1	Integer		Unit = mm
CL_Diam2	Integer		Unit = mm
CL_Diam3	Integer		Unit = mm
CL_InternalDiam1	Integer		Unit = mm
CL_InternalDiam2	Integer		Unit = mm
CA1_R	Integer		Refer to Akin et al (1993)
CA2_R	Integer		
CA3_R	Integer		
CA4_R	Integer		
CA5_R	Integer		
CA6_R	Integer		
CA_RIGHT	Integer		# CAs, right ovary; sum of CA*_R fields, if CA types counted
CA1_L	Integer		
CA2_L	Integer		
CA3_L	Integer		
CA4_L	Integer		
CA5_L	Integer		
CA6_L	Integer		
CA_LEFT	Integer		#CAs, left ovary; sum of CA*_L fields, if CA types counted
TotalCorpora	Integer		=CA_RIGHT + CA_LEFT; Examination of both ovaries required for data entry in this field
CL_LocationID	Integer	Foreign key	tblCode_CL_Location
FetusLength_Standard	Real		to nearest 1/10 cm
FetusLength_Curvilinear	Real		to nearest 1/10 cm
FetusSex	Character	M, F, U	M, F or U for Male, Female or Unknown
FetusWeight	Real		to nearest 1/10 gram
GonadWeight_R	Real		to nearest 1/10 gram
GonadWeight_L	Real		to nearest 1/10 gram
WeightWOEPI_R	Real		to nearest 1/10 gram
WeightWOEPI_L	Real		to nearest 1/10 gram
TestisLength_R	Real		to nearest mm
TestisWidth_R	Real		to nearest mm
TestisDepth_R	Real		to nearest mm
TestisLength_L	Real		to nearest mm
TestisWidth_L	Real		to nearest mm
TestisDepth_L	Real		to nearest mm
Comments	Character		<= 100 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_RSFoodHabits

Note: This table stores rough-sorted data for stranded and California gillnet specimens as well as prey identification details for eastern tropical Pacific tuna fishery specimens. For the former, weights and counts of fish and squid prey recovered are recorded (*i.e*., through column "OTOLITH_PRESENT_M"). For the latter, species prey names are the column names.

Field Name	Type	Validation	Description
ID	Integer	Primary key	auto-entered
SNUMBER	Character		Stomach ID number assigned when rough sorted; <= 10 characters
Specimen	Character	Foreign key	must match tbl_Animal record
INIT_WT	Real		
FINAL_WT	Real		
PREY_WT	Real		
SQ_PRESENT	Integer		Y or N for Yes or No
SQUID_WGHT	Real		
SQUIDBEAK_VIALS_F	Integer		
SQUIDBEAK_PAIR_F	Integer		
SQUIDBEAK_UPPER_F	Integer		
SQUIDBEAK_LOWER_F	Integer		
SQUIDBEAK_UNDETER_F	Integer		
SQUIDBEAK_PRESENT_M	Character		Y or N for Yes or No
OTOLITH_VIALS_F	Integer		
OTOLITH_PAIR_F	Integer		
OTOLITH_RIGHT_F	Integer		
OTOLITH_LEFT_F	Integer		
OTOLITH_UNDETER_F	Integer		
OTOLITH_PRESENT_M	Character		Y or N for Yes or No
O_BARTRAMII	Character		See Robertson and Chivers (1997) for species names
O_RUBESCENS	Character		
O_CF_RUB	Character		
D_GIGAS	Character		
S_OUALANIE	Character		
ENOPLO	Character		
E_LUMINOSA	Character		
H_PELAGICA	Character		
N_HAWAIIEN	Character		
OMMASTRE_2	Character		
OMMASTRE_3	Character		
OMMASTRE_4	Character		
OMMASTRE_5	Character		
O_BANKSII	Character		
ONYCHO_1	Character		
ONYCHO_2	Character		
A_LESUEURI	Character		
A_FELIS	Character		
A_NOURYI	Character		
P_GIARDI	Character		
ABRAL_SP_B	Character		
ABRAL_AFFI	Character		
HISTO_SP	Character		
H_HETEROPS	Character		
H_DOFLEINI	Character		
H_MELEAGRO	Character		
C_SICULA	Character		
C_CALYX	Character		
M_DENTATA	Character		
M_PYRODES	Character		
G_SP	Character		
UNID_GONATIDS	Character		
G_BONPLANDI	Character		

Field Name	Type	Validation	Description
G_ONYX	Character		
G_BOREALIS	Character		
G_BERRYI	Character		
G_CF_BERRYI	Character		
G_PYROS	Character		
P_BOSCHMAI	Character		
L_OPALESCENS	Character		
L_DISLOCAT	Character		
L_REINHARD	Character		
MEGALOCRAN	Character		
O_DELETRON	Character		
OCTOPOTEUT	Character		
T_RHOMBUS	Character		
V_INFERNALIS	Character		
ARCHITEUTH	Character		
UNKNOWN_1	Character		
UNKNOWN_2	Character		
UNKNOWN_4	Character		
ARGO_TYPE_A	Character		
J_HEATHI	Character		
A_MOLLIS	Character		
T_VIOLACEUS	Character		
UNID_UPPER	Character		
SQUID_M	Real		
FISH_PRESENT	Integer		
FISH_WEIGHT	Real		
S_SPP	Character		
S_EVERMANNI	Character		
S_ARGENTEA	Character		
S_POLITUS	Character		
S_CAERULEUS	Character		
S_JAPONICUS	Character		
S_SAGAX	Character		
M_ASPERUM	Character		
M_AUROLATE	Character		
M_PHENGODE	Character		
M_PRODUCTUS	Character		
D_MOLLIS	Character		
D_SPLENDID	Character		
G_LINEATUS	Character		
L_LUMINOSA	Character		
L_PARVICAU	Character		
L_IDIOSTIG	Character		
L_OMOSTIGM	Character		
L_FESTIVUS	Character		
H_PROXIMUM	Character		
H_REINHARD	Character		
D_LATERNAT	Character		
N_RESPLEND	Character		
T_SYMMETRICUS	Character		
T_CRENULAR	Character		
T_MEXICANU	Character		
S_GUETHERI	Character		
R_STEARNSI	Character		
CERATOS_SP	Character		
UNID_MYCTO	Character		
B_BATHYMAS	Character		
E_MORDAX	Character		
E_VOLITANS	Character		
EMBIOTOCIDAE	Character		
O_MICROPTE	Character		
O_SCRIPPSI	Character		
C_EURCATUS	Character		
C_CARINATU	Character		
C_BAXTERI	Character		

Field Name	Type	Validation	Description
C_NOBILIS	Character		
C_PUNCT	Character		
C_SORDIDUS	Character		
C_TAYLORI	Character		
A_THAZARD	Character		
P_SP	Character		
P_CLATHRATUS	Character		
P_NEBULIFER	Character		
P_MYRIASTER	Character		
P_NOTATUS	Character		
P_VETULUS	Character		
SCIANIDAE	Character		
SERRANIDAE	Character		
CF_CCAL	Character		
CF_KYPHOCIDAE	Character		
UNID_FLATFISH	Character		
UNID_OTOLI	Character		
OTOLITH_M	Real		
MAIN_STOM_PREY_PRESENT	Integer		
CRUSTACEA	Real		
GASTROPODS	Real		
PARASITES	Real		
NEMATODE	Character		
ANASKIS_SP	Character		
ISOPODS	Real		
MILK	Integer		
FOR_OBJ	Character		
DNA_SAMPLE	Integer		
NOTES	Character		
WHO_SORTED	Character		
DATE_SORTED	Character		

tbl_StableIsotope

Field Name	Type	Validation	Description
ID	Integer	Primary key; auto-entered	
Specimen	Character	Foreign key	must match tbl_Animal record
TissueTypeID	Integer	Foreign key	tblCode_TissueType
Preservative	Character		Enter Dry, DMSO, Frozen etc.; <= 10 characters
SetName	Character		Assigned by processing lab
SampleNumber	Character		Accession number assigned by processing lab
ProcessingLab	Character		Identifies lab that processed sample
ExtractionMethod	Character		Specify Bulk, Lipid Extracted etc
C_N_Ratio	Real		
D13C	Real		
D15N	Real		
Weight_pct_C_MS	Real		
Weight_pct_N_MS	Real		
Comments	Character		<= 300 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_StageDetermination

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
IsFetalFold	Character	Y, N	Y or N for yes or no
IsLingualPapillae	Character	Y, N	Y or N for yes or no
IsLungExpand_histo	Character	Y, N	Y or N for yes or no
IsLungFloat	Character	Y, N	Y or N for yes or no
IsPostAnalHump	Character	Y, N	Y or N for yes or no
IsRostralHairPresent	Character	Y, N	Y or N for yes or no
IsTeethEruptLower	Character	Y, N	Y or N for yes or no
IsTeethEruptUpper	Character	Y, N	Y or N for yes or no
IsUmbilicusHealed	Character	Y, N	Y or N for yes or no
Vertebrae_Fused	Character	Y, N	Y or N for yes or no
Vertebrae_Open	Character	Y, N	Y or N for yes or no
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_StrandingDescription

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
IsSDCounty	Character	Y, N, U	Y or N for yes or no to indicate if stranding occurred within San Diego County, or U for unknown and cannot be determined
SDCountyMapID	Integer		See Appendix 8 for San Diego County Map codes (no lookup table)
RecoveryLocation	Character		General collection location: Beach, Float, Kelp, Other (Add comment), SPSP (spotted or spinners dumped by tuna fishery in port)
RecoveryConditionID	Integer	Foreign key	tblCode_CarcassCondition
RecoveryDispositionID	Integer	Foreign key	tblCode_RecoveryDisposition
Tag_Number	Character		typically for pinnipeds
Tag_Color	Character		typically for pinnipeds
SampleDisposition	Character		descriptive; who received what
PathologyCase	Character		accession # assigned by pathologist
RadiologyID	Integer	Foreign key	tblCode_Radiology
IsStomachExamined	Character	Y, N, P	Y, N or P for yes, no or possibly
IsPredatorWound	Character	Y, N, P	Y, N or P for yes, no or possibly
IsGunShot	Character	Y, N, P	Y, N or P for yes, no or possibly
IsEntangled	Character	Y, N, P	Y, N or P for yes, no or possibly
IsShipStrike	Character	Y, N, P	Y, N or P for yes, no or possibly
IsOtherHumanRelated	Character	Y, N, P	Y, N or P for yes, no or possibly
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

tbl_Weight

Field Name	Type	Validation	Description
Specimen	Character	Primary key	must match tbl_Animal record
Adrenal_1	Real	< 200 g	nearest 1/10 gram
AdrenalSide_1	Character	R, L, U	R, L or U for right, left or unknown
Adrenal_2	Real	< 200 g	nearest 1/10 gram
AdrenalSide_2	Character	R, L, U	R, L or U for right, left or unknown
Blubber	Real		nearest 1/10 gram
Brain	Real	< 4000 g	nearest 1/10 gram
Carcass_Intact	Real		nearest gram; no estimates
Epaxial	Real		nearest gram
Heart	Real	< 15000 g	nearest 1/10 gram
Hypaxial	Real		nearest gram
Intestines	Real		nearest 1/10 gram
Intestine_Length	Real		to nearest cm
Kidney_R	Real	< 9000 g	nearest 1/10 gram
Kidney_L	Real	< 9000 g	nearest 1/10 gram
Lung_R	Real	< 15000 g	nearest 1/10 gram
Lung_L	Real	< 15000 g	nearest 1/10 gram
Liver	Real		nearest 1/10 gram
Misc	Real		nearest gram
Muscle_Total	Real		nearest gram
Pancreas	Real	< 1000 g	nearest 1/10 gram
Spleen	Real	< 400 g	nearest 1/10 gram
Stomach_Full	Real	< 10000 g	nearest 1/10 gram
Stomach_Empty	Real		nearest 1/10 gram
Thymus	Real		nearest 1/10 gram
Viscera	Real		nearest gram
Comments	Character		<= 200 characters
EditDate	Date	Short date; auto-entered	Date record edited
EditUserID	Integer	Foreign key; auto-entered	Identifies person who edited record; SWFSCCommon.tblUser
RecordCreationDate	Date	Short date; auto-entered	Date record created

Appendix 6. Code tables for the Marine Mammal Life History (MMLH) database.

Table A6-1. MMLH code table: tblCode_CarcassCondition. ID = primary key and foreign key link from other tables.

ID	Description
1	Alive
2	Fresh dead
3	Moderate decomposition
4	Advanced decomposition
5	Mummified/Skeletal
6	Dead - Condition Unknown

Table A6-2. MMLH code table: tblCode_CL_Location. ID = primary key; CL_Code = foreign key link from other tables.

ID	CL_Code	Description	Comments
1	0	Left Ovary, Fetus in Left Horn	
2	1	Right Ovary, Fetus in Right Horn	
3	2	Left Ovary, Fetus in Right Horn	
4	3	Right Ovary, Fetus in Left Horn	
5	4	Left Ovary, No Fetus Found	
6	5	Right Ovary, No Fetus Found	
7	6	Left Ovary, Fetus Location Unknown	code added in 2005
8	7	Right Ovary, Fetus Location Unknown	code added in 2005
9	8	Left ovary, no fetus info	
10	9	Right ovary, no fetus info	
11	10	CL present, side unknown	

Table A6-3. MMLH code table: tblCode_Collection. ID= primary key. Additional information, including addresses, which rely on SWFSCCommon code tables for City, State and Country, and primary contact/curator for each collection is included in the table but not displayed here.

ID	Collection Acronym	Collection Name	Location
1	USNM	National Museum of Natural History, Smithsonian Institution	Washington DC, USA
2	LACM	Natural History Museum of Los Angeles County	Los Angeles, CA, USA
3	NSMT	National Museum of Nature and Science	Tokyo, Japan
4	CAS	California Academy of Sciences	San Francisco, CA, USA
5	CMNMA	Canadian Museum of Nature	Ottawa, Canada
6	MHNLR		La Rochelle, France
7	SDNHM	San Diego Natural History Museum	San Diego, CA, USA
8	SWFSC	Southwest Fisheries Science Center, Marine Mammal Osteology	La Jolla, CA, USA
9	AMNH	American Museum of Natural History	New York, NY, USA
10	BMNH	British Museum of Natural History	London, England
11	MCZ	Museum of Comparative Zoology	Harvard, MA, USA
12	MVZ	Museum of Vertebrate Zoology, University of California	Berkeley, CA, USA
13	NMML	National Marine Mammal Laboratory	Seattle, WA, USA
14	ZMA	Zoological Museum Amsterdam, University of Amsterdam	Amsterdam, Netherlands
15	RNH		Leiden, Netherlands
16	UPS		Tacoma, WA, USA
17	SNOMNH	Sam Noble Museum of Natural History, University of Oklahoma	Norman, OK, USA
18	MNHN	Muséum national d'Histoire naturelle	Paris, France
19	SBMNH	Santa Barbara Museum of Natural History	Santa Barbara, CA, USA
20	BAI		Berne, Switzerland
21	FMNH	Field Museum of Natural History	Chicago, IL, USA
22	MOLR		
23	NOSC		San Diego, CA, USA
24	SW	Sea World, San Diego	San Diego, CA, USA
25	UCLA	UC Los Angeles	Los Angeles, CA, USA
26	SIO	UC San Diego, Scripps Institute of Oceanography	La Jolla, CA, USA
27	SWFSC-MMASTR	Marine Mammal and Marine Turtle Molecular Genetics	La Jolla, CA, USA
28	UWBM	Burke Museum, University of Washington	Seattle, WA, USA
29	PSM	Slater Museum of Natural History	Tacoma, WA, USA

Table A6-4. MMLH code table: tblCode_Color. ID= primary key and foreign key link from other tables. These codes apply to pantropical spotted dolphins only, and descriptions of the color phases can be found in Perrin (1969a).

ID	Description
1	Neonate
2	Two tone
3	Speckled
4	Mottled
5	Fused

Table A6-5. MMLH code table: tblCode_GonadType. ID = primary key and foreign key link from other tables.

ID	Description
1	Ovary
2	Testis
3	Epididymis
4	Testis and Epididymis
5	Uterus
6	Vagina
7	Unspecified

Table A6-6. MMLH code table: tblCode_MaleHisto. ID = primary key; Code = foreign key link for tbl_MaleHistology. Column labeled "InterTiss_Space" applies to coding for fields InterstialTissue and InterstitialSpace; "Lumen" is for Lumen; "TElon_Sperm" for TubuleElongation and spermatogenesis products: Spermatocytes, Spermatids and Spermatozoa; "Maturity" for MaturityCode.

ID	Code	InterTiss_Space	Lumen	TElon_Sperm	Maturity
1	0	Not Valid	None	None	Not valid
2	1	Little/Small	Small	Some or Few	Immature
3	2	Moderate/Medium	Medium	Most or All	Pubertal or Maturing
4	3	Abundant/Large	Large	Not Valid	Mature

Table A6-7. MMLH code table: tblCode_Maturity. ID = primary key; SexualMaturityCode = foreign key link from other tables.

ID	SexualMaturityCode	Description	Comments
11	0	Sexual maturity cannot be determined	
1	1	Sexually immature per gonad weight	
2	2	Sexually immature per histology	
3	3	Sexually immature, Total Corpora = 0	
4	4	Sexually immature, immature uterus	
5	5	Sexually mature per gonad weight	
6	6	Sexually mature per histology	
7	7	Sexually mature, Total Corpora >0	
8	8	Sexually mature; corpora albicans (>=1) or corpus luteum observed, total corpora count not available	
10	9	Sexually mature; no corpora info but pregnant or lactating	
12	10	Sexually immature per total body length	No gonad information available
13	11	Sexually mature per total body length	No gonad information available
14	12	Sexually maturing per histology	For males only

Table A6-8. MMLH code table: tblCode_MetalMoisture. ID = primary key and foreign key link from other tables.

ID	Description
1	Processing laboratory determined
2	Average of SWFSC sample tissues processed
3	Estimated from literature values

Table A6-9. MMLH code table: tblCode_Radiology. ID = primary key and foreign key link from other tables.

ID	Description
1	X-Ray
2	CT
3	MRI
4	CT & MRI

Table A6-10. MMLH code table: tblCode_Reader. ID = primary key and foreign key link from other tables.

ID	Initials	FirstName	LastName
1	WFP	William F.	Perrin
2	DBH	Dave B.	Holts
3			Clapp
4			Suanico
5	JMC	James M.	Coe
6	ACM	Albert C.	Myrick
7	JRH	John R.	Henderson
8		Mac	Kimura
9		Pricilla A	Sloan
10		C	Hui
11		Dana	Seagars
12		Viktor	Gurevich
13		James G.	Mead
14		Dan	Odell
15		Brent	Stewart
16		Toshio	Kasuya
17	RLB	Robert L.	Brownell
18	AAH	Aleta A.	Hohn
19	SJC	Susan J.	Chivers
20	KZP	Kelly M.	Robertson
21	MZH	Michael D.	Henshaw
22	RLN	Rebecca L.	Nachenberg
23	AT	Amanda	Toperoff
24	KXD	Kerri	Danil
25	AMB	Andrea M.	Bright
26	KKS	Kathryn Keiko	Sherman

Table A6-11. MMLH code table: tblCode_RecoveryDisposition. ID = primary key and foreign key link from other tables.

ID	Description
1	left@site
2	buried
3	towed
4	scientific collection
5	education Collection
6	other
7	landfill

Table A6-12. MMLH code table: tblCode_SpDetermination. ID = primary key; Code = foreign key link from other tables.

ID	Code	Description
1	A	FieldID
2	B	Genetics: method unknown
3	C	Genetics: cytochrome b
4	D	Genetics: dloop
5	E	Genetics: cytochrome b & dloop
6	F	FieldID & Genetics: cytochrome b
7	G	FieldID & Genetics: dloop
8	H	FieldID & Genetics: cytochrome b & D-Loop

Table A6-13. MMLH code table: tblCode_SpecimenOrigin. ID = primary key and is the foreign key link from other tables.

Note: The International Dolphin Conservation Program Act (IDCPA) was a 1997 amendment to the US Marine Mammal Protection Act that mandated research to evaluate the impact of the eastern tropical Pacific tuna fishery on dolphins.

ID	OriginDescription	Notes
1	ETP - tuna purse-seine fishery	Collected by observers 1968 - 1994
2	ETP - IDCPA necropsy program	1997-2002
3	CA gillnet fisheries: drift- & set- net	Collected by observers 1990 - present
4	Stranding - San Diego County	Transfers/Loans require Regional Coord approval
5	Stranding - Orange/LA County	Transfers/Loans require Regional Coord approval
6	Stranding - Other	Transfers/Loans require Regional Coord approval
7	NMFS Enforcement	
8	Other	Specify in LH_SAMPCOLLS comments
9	Unknown	
10	Stranding - Sea World	Transfers/Loans require Regional Coord approval
13	Research Take	Transfers/Loans require additional documentation

Table A6-14. MMLH code table: tblCode_TissueType. ID = primary key and foreign key link from other tables.

ID	Tissue
1	Blubber
2	Liver
3	Kidney
4	Muscle
5	Gonads
6	Teeth
7	Stomach
8	Stomach Contents
9	Adrenals
10	Biopsy
11	Fetus
12	Carcass
13	Head
14	Feces
15	Urine
16	Blood
17	Serum
18	Other - see Comments
19	Histo, full
20	Histo, other
21	Histo, full & other
22	Histo, immuno

Appendix 7. Data forms in use to record biological data.

Data form 1. *For the eastern tropical Pacific fishery observer program.*

Data form 2. *For the California gillnet fishery observer program.*

Data form 3. *Stranding report – Level A data*

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

Data form 4. *For the collection of biological data from cetaceans during necropsy.*

a) *Detailed data record.*

CETACEAN DATA RECORD

Field No._____

Species_____ Sex_____ Length_____ Condition_____
Lat. & Long._____ Date, occurrence _____, of data_____
Locality_____
Observer_____
Circumstances, cause of death_____
_____

External Description _____
_____
_____

Human Interaction Form Complete? _____ YES _____ NO
Tooth / baleen count: erupt_____ total_____ up L_____ up R_____ low L_____ low R_____

MEASUREMENTS (specify units_____) (*not parallel to body axis)

1. total length	_____	25. length of throat grooves	_____
2. snout to anus	_____	26. flipper length, anterior*	_____
3. snout to genital slit	_____	27. flipper length, posterior*	_____
4. snout to umbilicus	_____	28. flipper width, maximum*	_____
5. snout to throat grooves	_____	29. length mammary slits R____ L____	
6. snout to dorsal fin tip	_____	30. number of mammary slits	_____
7. snout to anterior dorsal fin	_____	31. length of genital slit _____ anal slit _____	
8. snout to flipper	_____	32. perineal length (males)	_____
9. snout to ear	_____	33. fluke width*	_____
10. snout to eye	_____	34. fluke depth* _____ lobe_____ notch_____	
11. snout to gape	_____	35. fluke notch depth*	_____
12. snout to blowhole	_____	36. dorsal fin height*	_____
13. snout to melon apex	_____	37. dorsal fin base length	_____
14. center of eye to ear*	_____	38. girth at eye*	_____
15. center of eye to gape*	_____	39. girth at axilla*	_____
16. center eye to blowhole edge, L*	_____	40. girth, maximum*	_____
17. center eye to blowhole edge, R*	_____	41. girth at anus*	_____
18. blowhole length ____ width*	_____	42. girth midway anus to notch*	_____
19. diameter ear opening	_____	43. height same place*	_____
20. head diameter at eyes*	_____	44. thickness same place*	_____
21. length of eye opening	_____	45. blubber thickness, dorsal*	_____
22. rostral width, melon apex*	_____	46. blubber thickness, lateral*	_____
23. projection upper/lower jaw	_____	47. blubber thickness, ventral*	_____
24. number of throat grooves	_____	48. blubber thickness, cervical*	_____

AGE DETERMINATION
umbilicus healed_____, fetal folds present_____, teeth erupt: up_____, lower_____, rostral hair_____
papillary projections_____, patent urachus____, post-anal hump____, lungs(circle): float sink

WEIGHTS (specify units)_____, type of scales_____

adrenal, left	_____	kidney, right	_____
adrenal, right	_____	liver	_____
brain	_____	lung, left	_____
carcass	_____	lung, right	_____
heart	_____	mesenteric lymph node	_____
intestine length	_____	pancreas	_____
intestines	_____	spleen	_____
kidney, left	_____	stomach,empty	_____

stomach, full _____
thymus _____
remarks _____

SPECIMEN COLLECTION CHECKLIST: note preservation (FRZN, FORM, ETOH)

adrenals _____	fetus _____	lung _____	stomach content _____
blood _____	genetics: skin _____	muscle _____	swab _____
blubber _____	muscle _____	attached to blubber Y/N	teeth/baleen _____
brain _____	gonads _____	photos _____	urine _____
ectoparasites _____	histology _____	skeleton _____	other _____
endoparasites _____	kidney _____	skull _____	_____
feces _____	liver _____	spleen _____	_____

REPRODUCTIVE SYSTEM

Female
ovaries: weight (g) R_____ L_____, dimensions (mm) (LxWxD) R_____ L_____
milk?_____ pregnant?_____; left horn/right horn; fetus: sex_____, weight (g)_____
fetal length (cm), snout to tail: cvl_____ sl_____, crown to rump_____

Male
testes: weight (g) w/ epididymis R_____ L_____, without R_____ L_____
dimensions (mm) (LxWxD) R_____ L_____
remarks _____

GONAD STAGING

Ln (mm)	SG	E	TUBULE DIAM (µm)		FOLL DIAM	CL	CL DIAMS.		CA (L)	CA (R)	TOTAL CORP CA - CL
RIGHT TESTIS					(mm)		(mm)				

STOMACH CONTENTS

fore: volume_____ fish_____ bones_____ otoliths_____ squid_____ beaks_____
main: volume_____ fish_____ bones_____ otoliths_____ squid_____ beaks_____

PATHOLOGY CHECKLIST

adrenal _____	kidney _____	pancreas _____	trachea _____
bladder _____	liver _____	rib _____	thymus _____
brain _____	lung _____	skin _____	thyroid _____
epididymis _____	lymph node _____	spinal cord _____	uterus _____
esophagus _____	mammary gland _____	spleen _____	vessel _____
heart _____	muscle _____	stomach _____	other _____
intestine _____	ovary _____	testis _____	

REMARKS: _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

10/20/16

b) Schematic to body locations for measurement and sample collection referenced in (a).
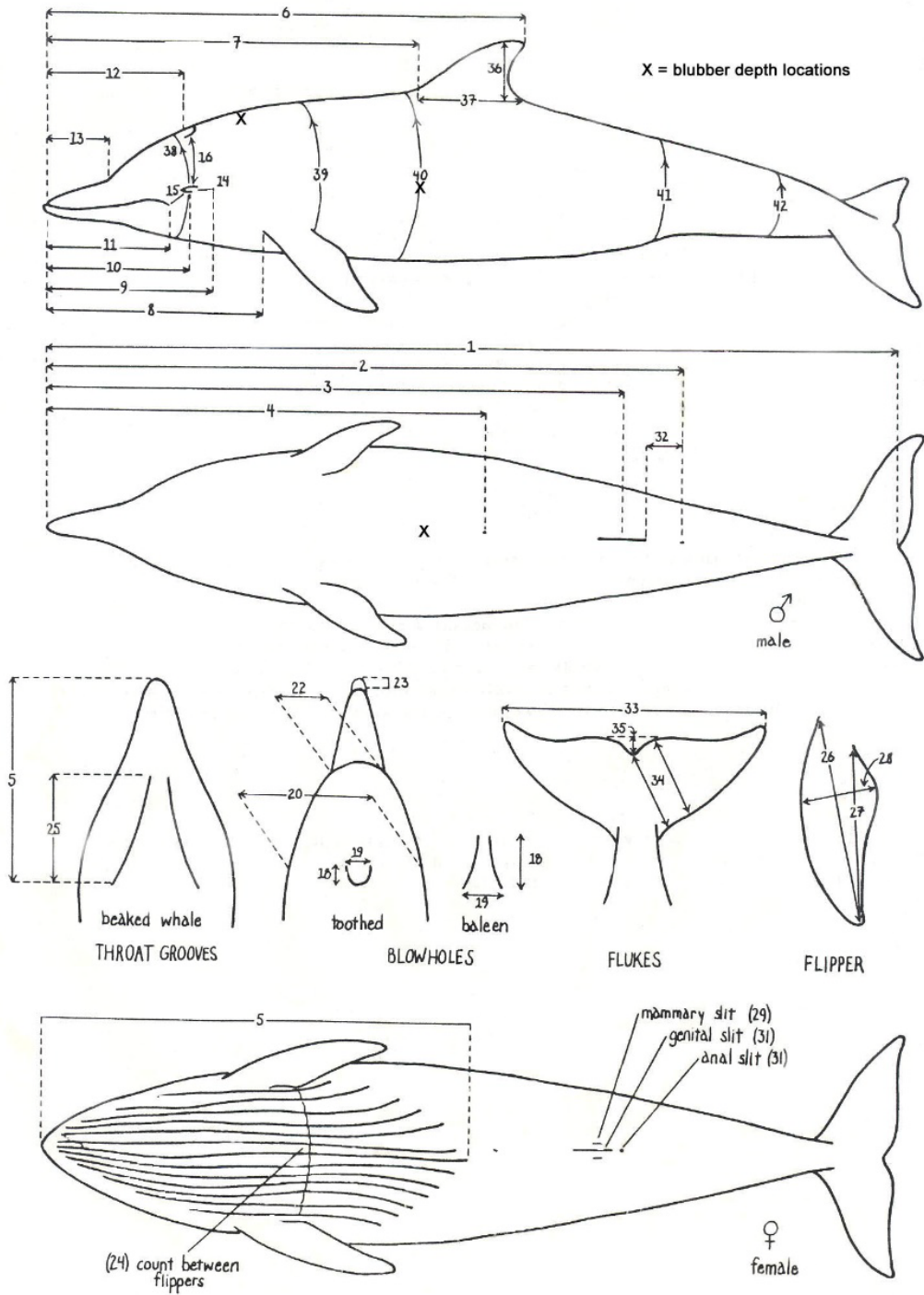
Appendix 8. San Diego County coastline map codes.

The codes are 1 – 11, and group beaches along the San Diego County coastline from the U.S.A/Mexico border to the San Diego/Orange County border. The map shown is Figure 1 from Danil et al. (2010).